

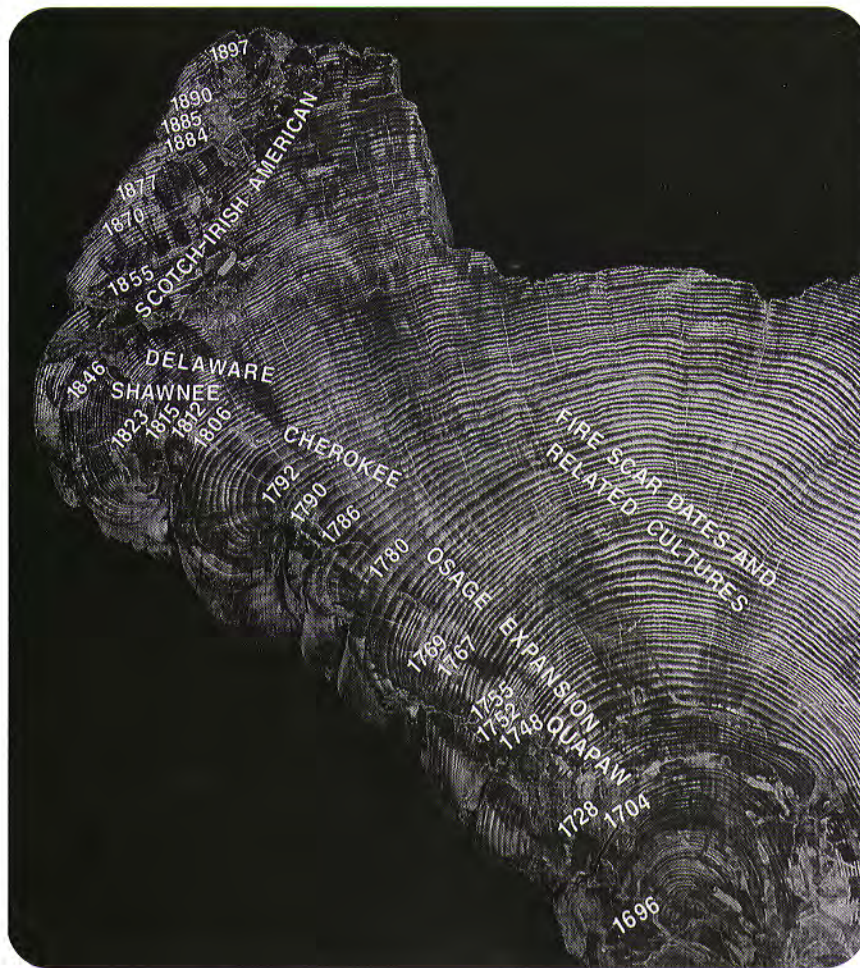
Forest Research



Department of Conservation

Report No. 1

Fire and logging
history at
Huckleberry Hollow,
Shannon County,
Missouri



**Fire and logging
history at
Huckleberry Hollow,
Shannon County,
Missouri**

by

Richard P. Guyette
The School of Natural Resources
1-30 Agriculture Bldg.
University of Missouri
Columbia, MO 65211

and

Daniel C. Dey
Missouri Department of Conservation
P.O. Box 180
Jefferson City, MO 65102

a report prepared for

The Missouri Department of
Conservation
P.O. Box 180
Jefferson City, MO 65102
573/751-4115

1997

 ABSTRACT

Guyette, Richard P. and Daniel C. Dey. 1997. Fire and logging history at Huckleberry Hollow, Shannon County, Missouri. Missouri Department of Conservation, Jefferson City, Missouri. Forest Research Report No. 1, 10 pages.

In Compartment 4 of the Missouri Ozark Forest Ecosystem Project, a fire history was constructed by dendrochronological analysis of dated fire scars found on shortleaf pine (*Pinus echinata* Mill.) stumps and natural remnants. The study site is an oak-pine forest located in two drainages (Huckleberry and Wolf Pen Hollows) along the Current River in Shannon County, Missouri. The mean fire interval (MFI) for the period of Euro-American settlement to 1930) was 2.2 years, and the MFI for the Native American period (1700 to 1820) was 7.1 years. Fires increased in frequency throughout both periods. As the number of people in Shannon County increased, so did the number of fires per decade from 1770 to 1910. Fires occurred in the study area during two years (1780 and 1728) in which large areas of the Current River watershed were burned. A fire in 1820 was severe enough to cause long-term reductions in diameter growth in individual shortleaf pine trees. We discuss the influence of population and settlement, topographic features, climate and fuels on the fire regime.

Past logging events were also identified using dendrochronological techniques to date diameter growth releases on freshly cut trees that were old enough to record turn-of-the-century harvesting. The forest in portions of Compartment 4 were partially cut in patches around 1920, 1935 and 1940. The shortleaf pine was preferentially removed in the earlier harvests. No harvesting has occurred in the area since it was acquired by the Missouri Department of Conservation in 1946.

TABLE OF CONTENTS

Abstract	i
Introduction	1
Methods	2-4
Study location	
Dating past harvest events	
Dating fire scars	
Results and Discussion	4-8
Historical timber harvests	
Fire history	
Conclusions	9
Literature Cited	10

LIST OF FIGURES

Figure 1. Location of Compartment 4, MOFEP.	2
Figure 2. Location of trees by their 20th Century growth release dates.	3
Figure 3. Location of fire-scarred pine remnants.	4
Figure 4. Temporal distribution of growth releases observed in the study trees.	5
Figure 5. Fire scar dates and composite fire scar chronology for Compartment 4.	6
Figure 6. Diameter growth decline associated with the 1820 fire.	7
Figure 7. Fire occurrence and human population in Shannon County.	7
Figure 8. Fire, growth and climate relationships by historic periods.	8

LIST OF TABLES

Table 1. Fire frequency and interval by historic periods.	6
---	---

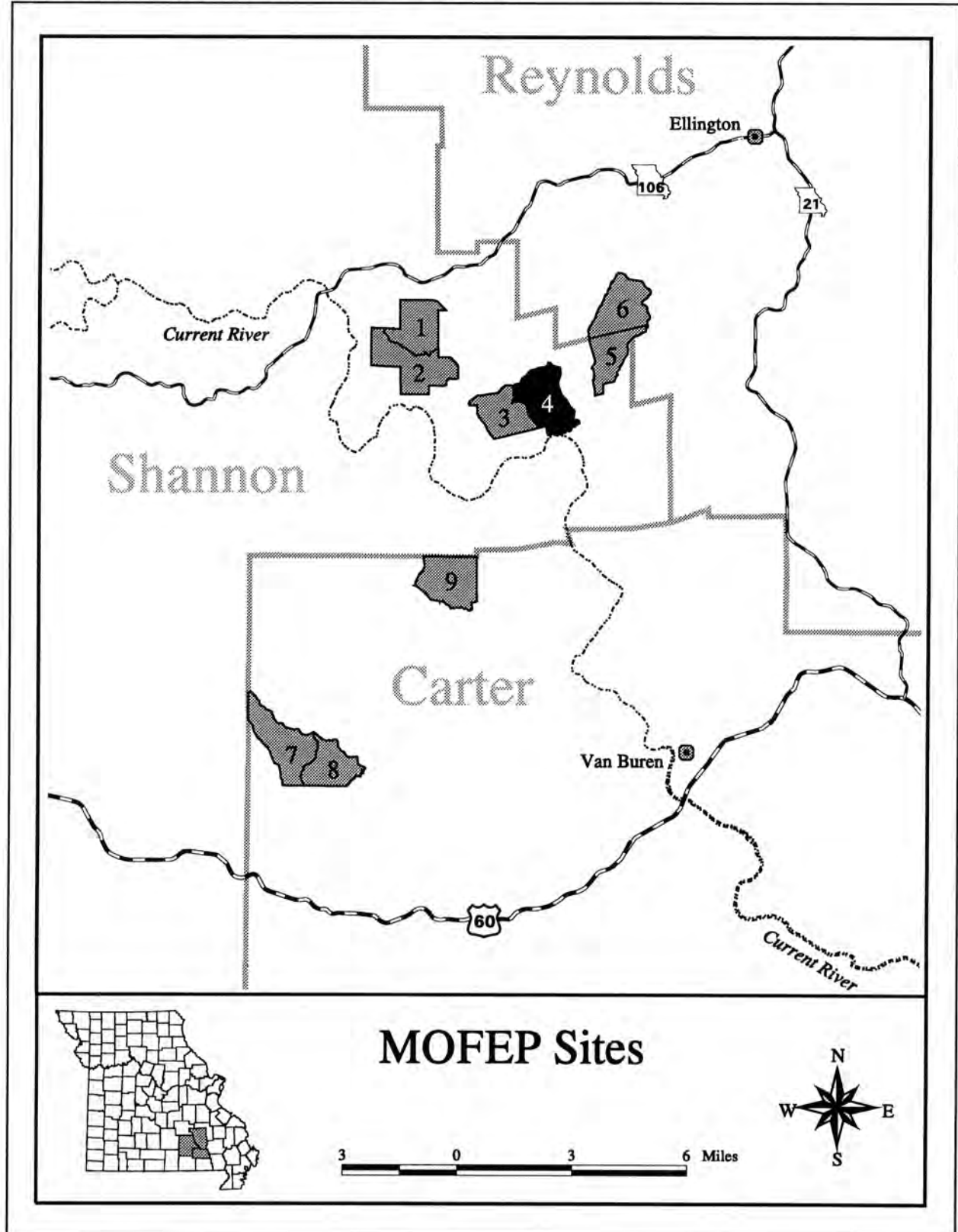
Disturbances such as windthrow, fire and timber harvest significantly effect how forest ecosystems develop. We have and continue to modify the nature of our forests through anthropogenic fire, fire suppression, and resource exploitation and management. Past disturbance histories, as well as current cultural practices and ecological processes, must be considered in order to improve our understanding of the dynamic nature of our forest systems and our ability to predict future forest conditions. Unfortunately, site-specific records of past land use practices and disturbance regimes are often limited or do not exist for much of the land we manage. Dendrochronological reconstruction of past disturbance events such as fire and timber harvest gives land managers a long-term perspective on which to base decisions concerning future land use.

The Missouri Ozark Forest Ecosystem Project (MOFEP) is a research project designed to evaluate the effects of traditional and alternative forest management practices on a wide range of resources that are important to (1) ecosystem function, (2) the health and quality of the forest, and (3) Missourians. An integral part of the MOFEP is to document the historical and current role of disturbances such as fire and timber harvest in upland oak-pine-hickory forests in the Ozarks. This knowledge will advance our understanding of how these forest systems will respond to changes in fire and timber harvest regimes.

This report is one of a number of fire and harvest histories that are being developed for the study sites in the MOFEI? Past fire and timber harvest events are determined for Compartment 4 of MOFEI? by analyzing (1) the fire scars found on shortleaf pine (*Pinus echinata* Mill.) stumps and natural remnants, and (2) the dates of growth release from freshly harvested live trees that are old enough to record past logging events. The objectives of this study are to:

- 1) develop a method for dating logging events at the stand and compartment level,
- 2) estimate logging dates and harvest methods from dates of growth releases, and
- 3) develop a fire history for Compartment 4.

Figure 1. Location of Compartment 4, MOFEP in Shannon, Carter and Reynolds Counties, Missouri.



Study location

Past fire history and logging events were reconstructed in Compartment 4 of the MOFEP, which is located in Cardareva Conservation

Area, Shannon County, Missouri (Secs. 28, 29, 30, 31, 32 and 33, T29N, R1W and Secs. 4 and 5, T28N, R1W) (Figure 1).

METHODS

The study site is in the Lower Ozark section of the Ozark Natural Division of Missouri (Thorn and Wilson, 1980). The primary forest cover type is black oak (*Quercus velutina* Lam.)-scarlet oak (*Q. coccinea* Muenchh.). Together these oak species make up about 50% of the overstory basal area. White oak (*Q. alba* L.) (13 to 22% of overstory basal area) and shortleaf pine (3 to 15% of overstory basal area) occur less frequently. Over 90% of Compartment 4 (1,218 acres) is in ecological landtypes 11, 17 and 18 (Miller, 1981).

Dating past harvest events

Freshly cut oak stumps (=48) from the 1996 harvest of Compartment 4, MOFEP (Brookshire et al., 1997) were examined for dates of growth release (Figure 2). Stumps along ridge roads were selected for use by the clarity and length of their ring record. Many of the black and scarlet oaks originated about 1900 and several white oaks were over 150 years old. Stumps had to have a record of annual rings that went beyond the first dates of harvest. Many stumps were not usable because of their short ring record (i.e., trees that regenerated after logging) or the lack of a complete record (e.g., trees with heart rot). Cross-dating of the stumps was done on the site. Narrow rings in the signature years 1911, 1913, 1914, 1930, 1934, 1936, 1952, 1954 and 1980 were used in visual cross-dating and ring counts. Growth releases were dated to the exact calendar year of first growth increase.

Figure 2. Location of trees by their 20th century growth release dates in the study area, Compartment 4, MOFEP (release dates = map number 900). Circled numbers represent two observations with the same release date.



METHODS

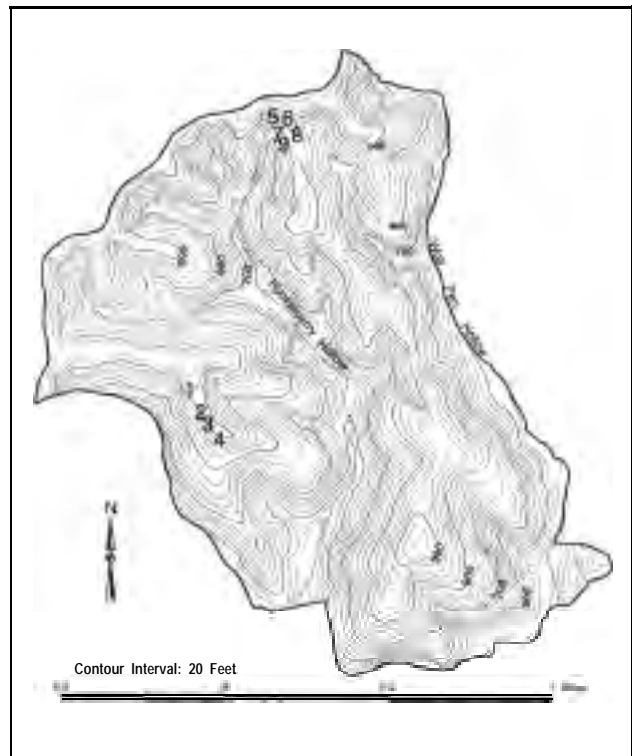
Dating fire scars

Nine cross-sections were cut from pine stumps and natural remnants in the watersheds of both Huckleberry and Wolf Pen Hollows (Figure 3). The cross-sections were surfaced with an electric hand planer and sanded or razor cut where necessary to measure and identify the annual rings. A radius (pith to bark ring series) of the cross-section, with the least amount of ring-width variability due to reaction wood, injury or callus tissue, was chosen for measurement. The measurement radius was also chosen for the maximum number of rings and high frequency ring-width variance. Ring-width series from each sample were measured and plotted. These plots were used for visual cross-dating. Signature years were used in the visual matching of ring-width patterns to improve cross-dating of the samples. Plots were also used to correct measurement errors and identify missing rings associated with injury or drought. A computer program, COFECHA (Holmes et al., 1986), was used to increase the accuracy of both relative and absolute dating of the samples by correlation analysis. Absolute dating of the pine remnants was accomplished by cross-dating with a ring-width chronology derived from live shortleaf pines growing within the study area in Shannon County, Missouri (on record at the International Tree-ring Data Bank, Boulder, CO).

Fires seldom scar all the trees in an area because of the variability in fuel loading, fuel arrangement, natural firebreaks, tree resistance

to scarring and other factors that affect fire intensity and behavior. Thus, estimates of fire frequency were calculated for a site by combining the scar data from several trees. A specialized fire history program, FHX2 (Grissino-Mayer, 1996), was used to plot a summary of the fire scar record at the site.

Figure 3. Location of fire-scarred pine remnants in Compartment 4, MOFEP.



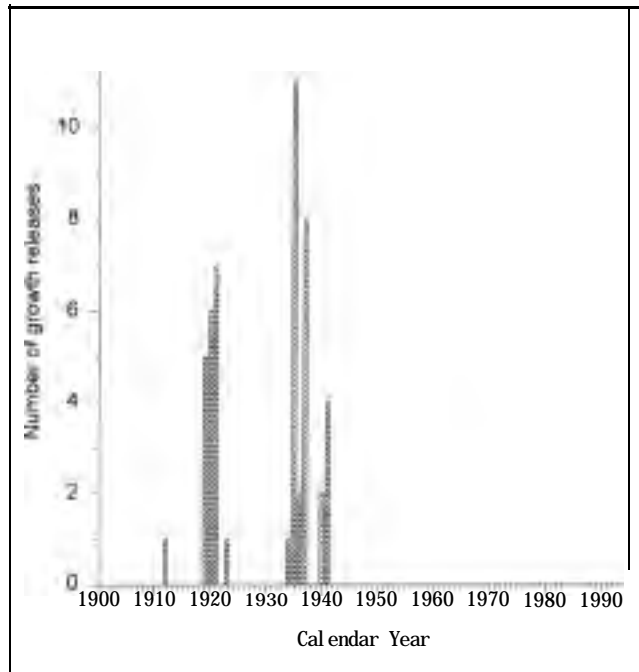
RESULTS AND DISCUSSION

Historical timber harvests

Nearly all of the growth releases dated were life change growth releases, i.e., growth releases that reflect the emergence of the tree as a dominant tree in the stand. After a release, ring width generally increased by a factor of 2-to-5 for a period of at least 20 years. These release dates represent the year of the growing season after the logging event. Basal scarring was noted on many trees in the same year as the growth release, and was attributed to mechanical injury during the logging operation and on associated slash fires. In the following discussion, cutting dates and release dates will be used synonymously.

The temporal distribution of growth release dates (Figure 4) indicated that harvesting occurred around 1920, 1935 and 1940 in the study area. These dates reflect the first three harvest periods for this site. The 1935 (1934 to 1937) harvest period was probably the most extensive as indicated by the 22 release dates (46% of all release dates). This period is closely followed by the 1920 (1919 to 1923) harvest period as the second most extensive harvest (37% of all release dates). Only about 13% of the harvest dates were from the 1940 period. About 20 years lapsed between the first and the last merchantable timber harvest.

Figure 4. Temporal distribution of growth releases observed in the study trees. Growth release dates are clustered in three groups, indicating that timber harvest occurred in this area around 1920, 1935 and 1940.



The spatial distribution of growth release dates (Figure 2) was clustered, with like dates occurring near one another. This indicates that logging proceeded in patches. Five areas had cutting dates from both the 1920 and a later period (either 1935 or 1940), indicating that during the 1920 period trees were cut selectively by species or grade. The northwest section of Compartment 4 had more cutting dates from the 1920 and 1940 period. The ridge between Huckleberry and Wolf Pen Hollows was cut very extensively during the 1935 period.

It is possible that a wind storm could cause similar individual patches of growth release by blowing down a substantial portion of the over-story. However, the spatial distribution of growth release dates in Compartment 4

preclude anything other than a very extensive, severe wind storm from producing a similar release response in so many widely distributed surviving trees. In addition, basal scarring was noted on many of the sample trees in the year of growth release, which we attributed to damages caused by logging operations.

Analysis of the outside ring dates (1927, 1918, 1912, 1911, 1907, 1906, 1893 and 1884) of cut pine stumps indicates that shortleaf pine was cut in the 1920, 1935 or 1940 harvests. The older outside ring dates suggest that there may have been a very light pine harvest before 1920, but this is somewhat speculative because the outside wood of all the sample pines has been lost to decay, making it impossible to determine the exact harvest date. However, these dates do indicate that the majority of the shortleaf pine was not harvested from the site until the 1920s or later. This is consistent with the findings from the harvest date/growth release portion of this study, which indicated that the first harvests at this site occurred circa 1920 and 1935. It also provides strong evidence that the pine was preferentially removed in the first harvests.

The Missouri Conservation Commission purchased the Cardareva Conservation Area from the Egyptian Tie & Timber Company on February 1, 1946 but permitted the harvest of timber, excluding pine, over 10 inches in diameter two feet above the ground until May 1, 1947. Since 1947, the Missouri Department of Conservation has not harvested timber from the Cardareva Conservation Area (personal communication 1997, Jason Jensen, Resource Forester, MDC, Ellington, MO). This largely explains the lack of any growth releases since the early 1940s.

RESULTS AND DISCUSSION

Fire history

All nine of the cross-sections were dated by dendrochronological methods. The mean between-tree correlation in ring width was 0.57 (ranging from 0.40 to 0.71). Dated tree-rings ranged from 1659 to 1927 in the nine samples. Only one sample had an intact pith, which dated to 1659. The unusually high percentage of dating success indicated that pine growth at the site was strongly influenced by climate.

Dated fire scars and the tree-ring records are plotted in Figure 5, with a composite fire history for the study site. The mean fire interval (MFI) before 1820 is about 7.1 years while after 1820 it is 2.2 years (Table 1). Also, the range in individual fire-free periods is less after

1820 than before. The year 1820 has been used in other studies (Guyette, 1996) to separate the Native American Period from the Euro-American Settlement Period.

In 1820, 1846 and 1884, 38% to 50% of the trees were scarred, indicating that fire intensity was severe. The intensity of the 1820 fire may have been very severe because it not only scarred many trees, but also caused abrupt and prolonged reductions in diameter growth in three of the nine pines (Figure 6). The years 1780 and 1728 were two of the largest fire years (in terms of area burned) in the Current River watershed (Guyette, 1996) and elsewhere (Guyette and Dey, 1995). Fire in these years are

Figure 5. Fire scar dates on trees (open flames) and a composite fire scar (closed flames)

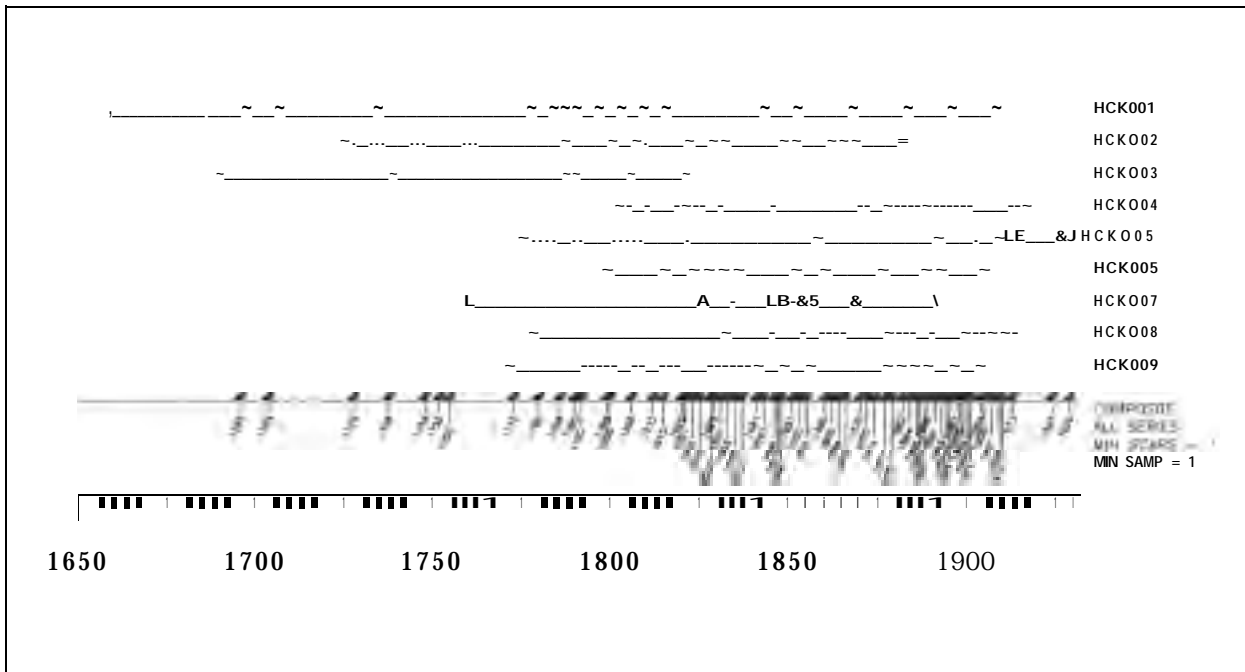


Table 1. Fire frequency and interval at Huckleberry Hollow(MOFEP) Compartment 4) by historic period (data are in years).

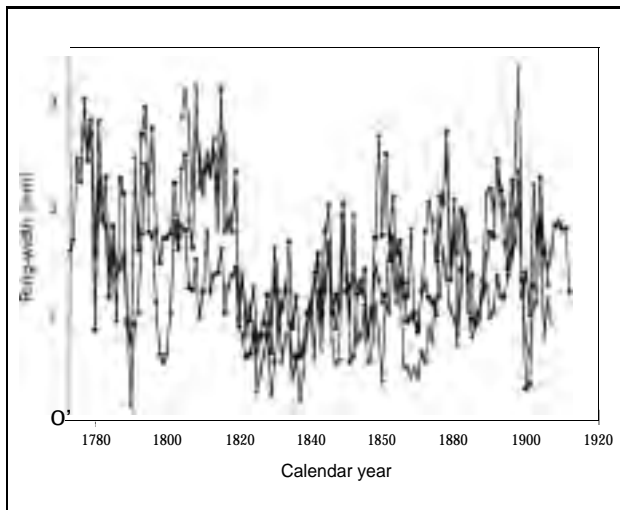
Period	Mean fire interval	Range
1930 to 1821	2.2	1 to 11
1820 to 1700	7.1	1 to 24

RESULTS AND DISCUSSION

represented at Huckleberry Hollow by one fire scar each. Huckleberry Hollow also burned in 1704 and 1800 (ranked 4th and 9th in area burned, respectively) when fires burned large areas in the Current River watershed.

Fires were relatively frequent in Compartment 4 before 1820. Although the highly dissected terrain in and around Compartment 4 is a potential barrier to the spread and frequency of fires, other landscape features combine to enhance the likelihood of fire in the study area. The drainages in this area face south, the direction of prevailing winds, especially during fire weather (Figure 3). Elevations within the Compartment differ by about 460 feet between the uplands and the

Figure 6. Ring-width plots from three sample trees illustrating an abrupt growth decline associated with fire scarring in 1820.

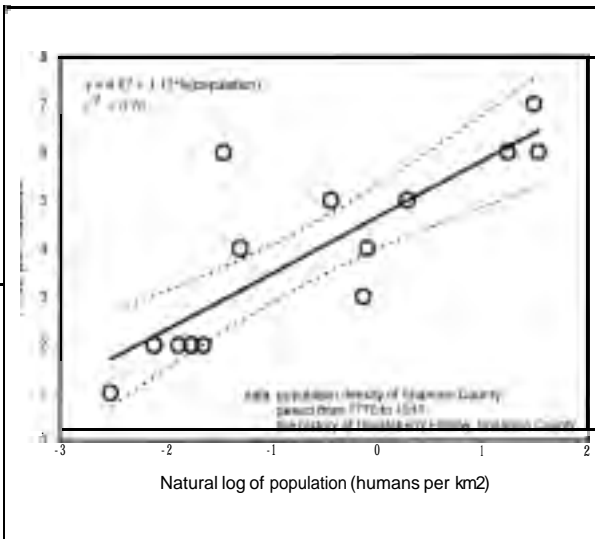


Current River. Fertile terraces along the river bottoms have attracted agriculture both in the distant (Lynott, 1989; Price and Price, 1986) and recent past (Stevens, 1991; Rafferty, 1980). Archeological sites document this activity on the river terraces, and old fields still lie along the river and at the mouth of Huckleberry Hollow. Fire was an integral part of agricultural and human activities. Thus, landscape position, slope (Chandler et al., 1983), winds and proximity to ignitions along the river corridor combine to facilitate the spread of fire uphill and down wind into Compartment 4.

In Compartment 4, the number of fires per decade increased, as did the Shannon County population density, during the period 1770 to 1910 (Figure 7).

A natural log transformation of human population census data and early population estimates was highly correlated ($r = 0.84$, $p < 0.05$) with the number of fires per decade during this period.

Figure 7. Scatter plot and regression of fires per decade and human population estimates in Shannon County. Human population data is from census data and population estimates for the period 1770 to 1910. The regression is significant ($p < 0.01$). The dashed line indicates the 95% confidence interval for the regression.



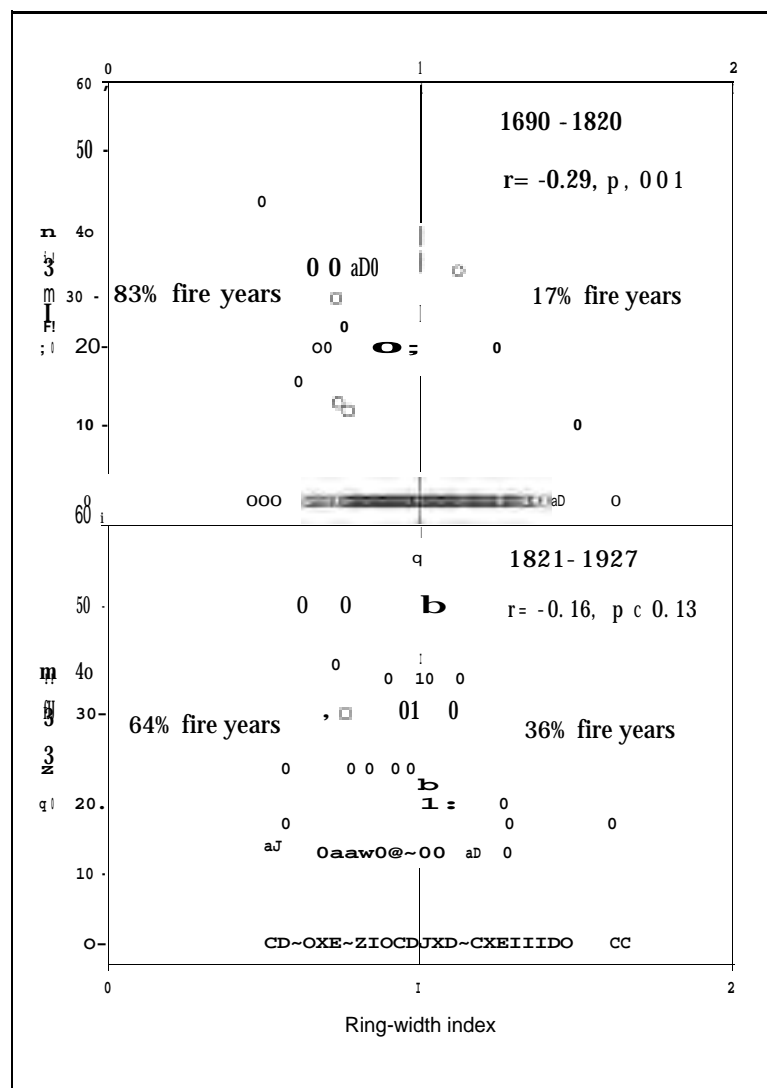
An abrupt increase in fire frequency in the 1820s may be the result of Native American migration through the area and early Euro-American settlement of Current River's fertile river terraces near the study site. The Delaware inhabited the Current River watershed from about 1815 to 1822 (Stevens, 1991). In November, 1820, 1,346 people of the Delaware nation and their horses (1,499) were ferried across the Missouri River (Weslager, 1978). Poor health and a lack of provisions forced them to make an emergency encampment on the west fork (Jacks Fork) of the Current River. More Delaware migrated to this area in the following years. This encampment was the first large population to live in the upper Current River for many years, which in part, ended a long period of low population density. This migration into the region of the MOFEP study area marked the beginning of a period of intensive human disturbance, which included increases in hunting pressure and pogenic fires, and the introduction of horses and associated parasites.

RESULTS AND DISCUSSION

Analysis of fire scar data before and after 1820 indicates a change in the fire, fuel and climate relationship. The percentage of trees scarred was significantly correlated ($r = 0.29$, $p < 0.01$) with pine ring-width indices before 1820 but not after (Figure 8). This is consistent with findings in an earlier report (Guyette, 1996). More frequent burning after 1820 may have reduced fuel loads to the point that climate no longer was a significant factor influencing the percentage of trees scarred. Periods before and after 1820 still show fire years being more likely

during years with narrow ring-width (warm, dry years), but the relationship weakens in the Euro-American Period. About 83% of the fire years before 1820 occurred in years with below average ring-width while after 1820 only about 64% of the fire years were related to dry years that limited diameter growth. The higher frequency of fire after 1820 probably reduced the fuel loading, thus limiting fire spread and intensity. Fuel had become more limiting to fire frequency and intensity than climate.

Figure 8. Scatter plots of the percentage of trees scarred versus a shortleaf pine ring-width index for two periods: 1690 to 1820 and 1821-1927. Percentages given are for the number of fire years occurring in years of low (< 1) and high (> 1) ring-width index values.



CONCLUSIONS

A fire history was developed for an oak-pine forest located in the Huckleberry and Wolf Pen drainages (Compartment 4, Mofep that are tributaries of the Current River in Shannon County, Missouri. Fire frequency and change at this site is consistent with other fire histories completed elsewhere in the Current River watershed. The mean fire interval (MFI) for the period of Euro-American settlement (1821 to 1930) was 2.2 years, and the MFI for the Native American period (1700 to 1820) was 7.1 years. Fires increased in frequency throughout both periods. As the number of people in Shannon County increased, so did the number of fires per decade from 1770 to 1910. An abrupt increase in fire frequency in the 1820s may be the result of Delaware and early Euro-American settlement of Current River's fertile river terraces near the study site. The landscape position (primarily south facing drainages) along the river corridor (a source of human ignition) may have contributed to the frequent fires in the early period (1700 to 1820) and mitigated the effects of the highly dissected terrain in and around Compartment 4.

The percentage of trees scarred was significantly correlated with pine ring-width indices before 1820 but not after, indicating a change in the fire-climate relationship. About 83% of the fire years before 1820 occurred in years with below average ring-width (years of drought) while after 1820 only about 64% of the fire years occurred in dry years. More frequent fires after 1820 altered the fire-climate relationship because reduced fuel loadings limited the intensity and extent of fires more so than climate.

Fires occurred in the study area during two years (1780 and 1728) in which large areas of the Current River watershed was burned. The 1820 fire was severe as evidenced by the prolonged and significant growth reductions observed in several of the sample pines.

The older living trees in Compartment 4 were used to identify years of timber harvest. Diameter growth releases identified and dated by dendrochronological techniques indicated that harvesting occurred around 1920, 1935 and 1940. The forest was partially cut in patches, and shortleaf pine was preferentially removed in the earlier harvests. This method can be used to date historical timber harvest provided that the logging results in a detectable increase in annual diameter increment in the surviving trees. We assumed that increases in diameter increment were due to harvesting and that they occurred in the year of logging, or shortly thereafter. Reconstruction of logging events by this method is limited in time to the age of the oldest living trees in the stand or compartment.

In the absence of detailed stand records that document fire and logging history, dendrochronological methods can be used to reconstruct forest disturbances. This information can be used to better understand forest regeneration, succession and other ecological processes that influence the condition of our modern day forests. We are better able to anticipate changes in forest systems by improving our knowledge of historical disturbances that effect forest succession.

LITERATURE CITED

- Brookshire, B.L., R. Jensen and D.C. Dey. 1997. The Missouri Ozark forest ecosystem project: past, present and future. In Proc. Missouri Ozark forest ecosystem project symposium. B.L. Brookshire and S.R. Shifley, eds. June 3-5, 1997. St. Louis, MO. USDA Forest Service, North Central Forest Experiment Station. General Technical Report NC- (in press).
- Chandler, C., I? Cheney, I? Thomas, L. Traband and D. Williams. 1983. Fire in forestry. Vol. I: forest fire behavior and effects. Wiley-Interscience. New York. 450 p.
- Grissino-Mayer, H. 1996. Software for the analysis of fire history from tree-rings. Lab. of Tree-ring Research. Univ. of Arizona, Tucson, AZ.
- Guyette, R.P. 1996. A tree-ring history of wildland fire in the Current River watershed. Missouri Dept. Conserv. File Rep. Jefferson City, MO.
- Guyette, R.P. and D.C. Dey. 1995. A dendrochronological fire history of Opeongo Lookout in Algonquin Park, Ontario. Ont. For. Res. Inst. For. Res. Rep. No. 134. 4 p.
- Holmes, R.L., H.K. Adams and H. Fritts. 1986. Quality control crossdating and measuring. Lab. of Tree-ring Research. Univ. of Arizona, Tucson, AZ.
- Lynott, M.J. 1989. An archaeological evaluation of the Gooseneck and Owls Bend sites: Ozark National Scenic Riverways, Southeast Missouri. U.S. Dept. Interior. National Park Serv. Midwest Archaeological Center.
- Miller, M.R. 1981. Ecological land classification terrestrial subsystem - a basic inventory system for planning and management of the Mark Twain National Forest. U.S. Dept. Agric., For. Serv. Rolla, MO. 56 p.
- Price, J.E. and C.R. Price. 1986. Archaeological investigations in the Ozark National Scenic Riverways, Project No. CAR-640. Archaeological Survey of Missouri. Columbia, MO.
- Rafferty, M.D. 1980. The Ozarks land and life. Univ. Oklahoma Press. Norman, OK. 282 p.
- Stevens, D.L., Jr. 1991. A homeland and a hinterland the Current and Jacks Fork riverways. Historic Resour. Study Ozark National Riverways. National Park Serv. Van Buren, MO. 248 p.
- Thorn, R.H. and J.H. Wilson. 1980. The natural divisions of Missouri. In Trans. of the Missouri Acad. of Sci. 14: 9-23.
- Weslager, C.A. 1978. The Delaware Indian westward migration. Middle Atlantic Press. Wallingford, PA. 266 p.

